Summary Recommendations of the San Joaquin River Water Quality Management Group for Meeting the Water Quality Objectives for Salinity Measured at Vernalis and Dissolved Oxygen in the Stockton Deep Water Ship Channel

San Joaquin River Water Quality Management Group

June 2005

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1. Introduction and Summary Recommendations

The purpose of this paper is to summarize the work of the San Joaquin River Water Quality Management Group during the period from May, 2004 to June, 2005. The ideas, information and concepts contained in this paper will be used to assist policy makers in deciding what actions will be implemented to meet water quality objectives in the San Joaquin River, specifically the salinity objective at Vernalis and the dissolved oxygen objective (DO) in the Stockton Deep Water Ship Channel. Once agreement among policymakers has been reached regarding what action(s) will be taken to meet the objectives it is anticipated that an agreement and appropriate environmental review will occur. It is expected that the recommendations, ideas and data herein will be utilized by the United States Bureau of Reclamation and the Director of the State Department of Water Resources to help meet the requirements of HR 2828 and SB 1155. Relative to the recommendations herein, a final report of the San Joaquin River Water Quality Management Group will be prepared detailing its investigations, data developed and modeling that was done supporting these summary recommendations.

The San Joaquin River Water Quality Management Group evaluated a host of flow and load management measures seeking to achieve salinity and DO objectives. Its summary recommendations appear below in Table 1.

2. Primary Objective of the San Joaquin River Water Quality Management Group

The lower San Joaquin River (LSJR), from Mendota Pool to Vernalis, is listed on the Federal Clean Water Act's 303(d) list of impaired water bodies for salinity and boron. The Stockton Deep Water Ship Channel portion of the LSJR is on the 303 (d) list for DO. The 303(d) listings require the development of Total Maximum Daily Load targets (TMDLs) to provide a basis to regulate discharges of salinity, boron and oxygen-demanding substances. The Central Valley Regional Water Quality Control Board (CVRWQCB) has developed TMDLs for both salinity and boron and for DO depleting substances.[1] The CVRWQCB has adopted TMDLs and amendments to Water Quality Control Plan (Basin Plan) implementing the TMDLs for Salinity and Boron, and for

[1] See the CVRWQCB's website at http://www.swrcb.ca.gov/~CVRWQCB, Central Valley Region5/programs/tmdl for TMDL documents.

Table 1
Summary Recommendations

Salinity

1. Fully implement the West Side Regional Drainage Plan[2].

2. Further evaluate and pursue managed wetland drainage management actions to mitigate impacts of February through April drainage releases.

3. Develop a real-time water quality management coordination group involving LSJR tributaries, LSJR drainers and the DWR to coordinate reservoir release and SWP/CVP Project operations (head of Old River barrier and New Melones operations) to realize opportunities to improve water quality and increase the utility of stored water releases.

Dissolved Oxygen

4. Pursue additional use of the Head of Old River Barrier to augment flows in the LSJR and the Deep Water Ship Channel, consistent with the need to maintain adequate in-Delta water quality, water level and fishery protection.

5. Support for continued implementation of the City of Stockton's ammonia removal project at the Stockton WWTP.

6. Install the demonstration aeration project in the DWSC and continue the newly implemented upstream monitoring efforts to understand DO load producing discharges.

7. Evaluation of additional actions necessary for DO compliance at the DWSC following implementation and analysis of actions 1-5.

8. Establish a forum to evaluate ongoing changes in the water quality baseline and suggest further management actions to continue progress on water quality improvement.

[2] See Appendix A for description of the West Side Regional Drainage Plan

Dissolved Oxygen. These Basin Plan amendments are currently pending before the State Water Resources Control Board (SWRCB).

The water quality problems of the LSJR are complex. Due to the highly modified nature of the San Joaquin River, complete solutions to both salinity/boron and DO problems are not readily available by approaching the problem through a load reduction strategy alone. TMDLs adopted by the CVRWQCB for DO, and for salinity and boron indicated that load reduction alone will not meet the objectives. The CVRWQCB does not have the authority to regulate flow and thus its ability to effect solutions is limited to load-based solutions. Flow regulation is the domain of the SWRCB. Nor does the CVRWQCB have the authority to cause mitigation for facilities constructed and maintained by the federal government, specifically the Deep Water Ship Channel (DWSC). Recognizing that a load-based solution was practically limited and potentially counterproductive, a number of stakeholders interested in developing a feasible and integrated solution to LSJR water quality problems began to meet and then formed the San Joaquin River Water Quality Management Group (Group).

The Group is an informal group of stakeholders coming together to develop cooperative solutions to achieve the water quality objectives targeted by the TMDLs.[3] Participants within the Group have tools, management strategies and assets that can affect water quality in the River. These tools and assets include loading reductions but also include other alternatives that the CVRWQCB has no ability to implement or regulate.

The water quality objectives this plan intends to address are shown in Table 2.

Simply stated, the primary objective of the Group is to:

> ***Prepare and implement a plan to meet the water quality objectives for salt and boron at Vernalis and Dissolved Oxygen at the Stockton Deep Water Ship Channel in coordination with CALFED Stage I objectives***[4]

[3] Participants in the Group include: •U.S. Bureau of Reclamation •Department of Water Resources•Central California Irrigation District•Friant WaterUsers Authority•Grassland Water District•James Irrigation District•Merced Irrigation District•Modesto Irrigation District•Oakdale Irrigation District•San Luis Canal Company, Exchange Contractor•San Joaquin County and Delta Water Quality Coalition•San Joaquin County RCD•San Joaquin River Exchange Contractors Water Authority•San Joaquin Valley Drainage Authority•San Joaquin River Group•San Luis and Delta Mendota Water Authority•South San Joaquin Irrigation District• South Delta Water Agency •State Water Contractors• Stockton East Water District•Tranquility Irrigation District•Turlock Irrigation District•Venice Island RD 2023•California Farm Bureau•Western Growers

[4] This plan incorporates real-time management elements and other strategies contemplated in but not able to ordered under the CVRWQCB's TMDLs. It is consistent with the real time management strategy discussed in the salinity TMDL.

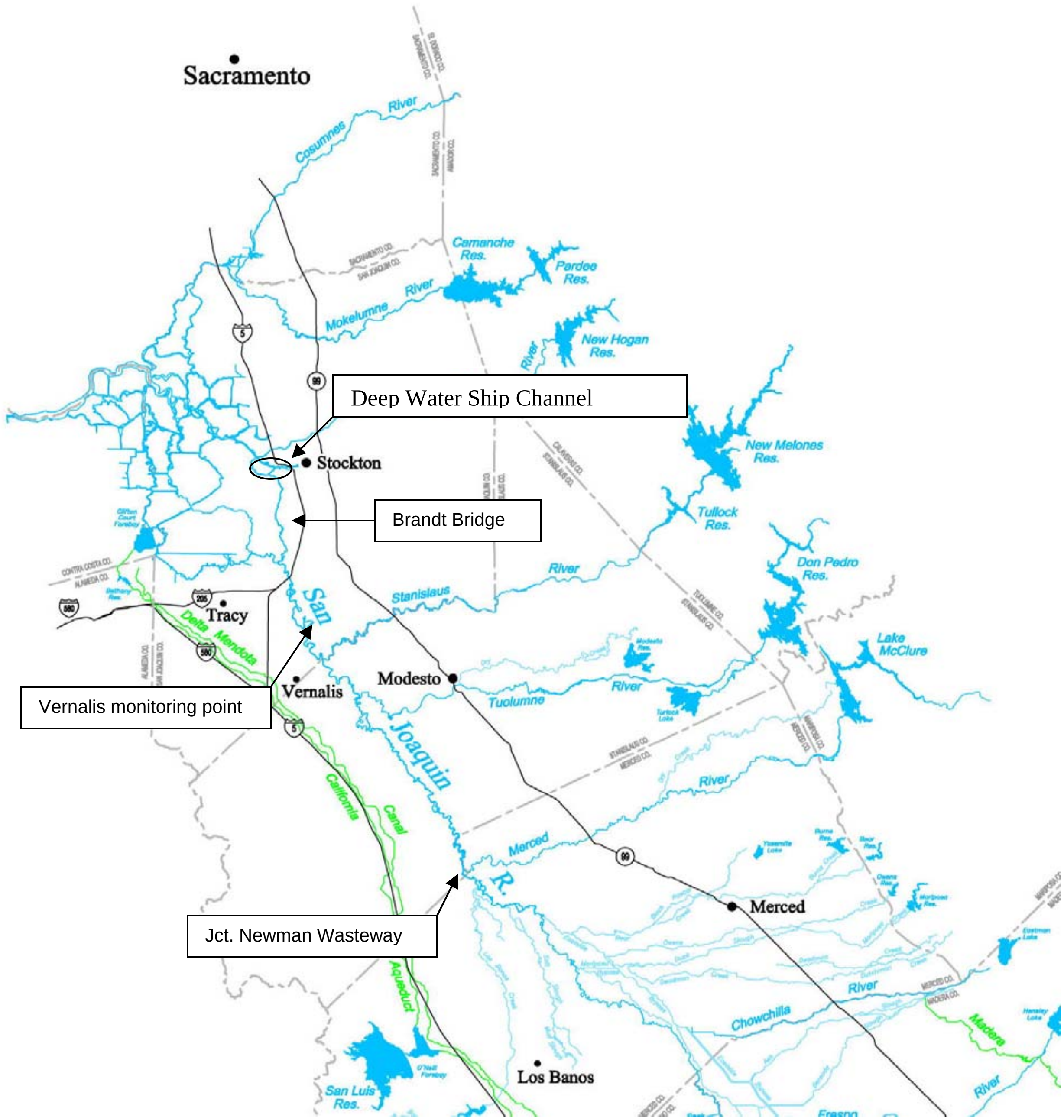
Table 2 Water Quality Objectives Addressed by the San Joaquin River Water Quality Management Plan	
Salinity and Boron : San Joaquin River at Airport Way Bridge, Vernalis, CA	Maximum 30 day running average of Electical Conductivity (EC) (*mmhos/cm*), all water year types: April-August 0.7 EC Sept.-March 1.0 EC
Dissolved Oxygen: San Joaquin River between Turner Cut and Stockton	Minimum DO (mg/l), all water years types, September-November – 6.0 mg/l, December-August 5.0 mg/l

3. Secondary Objectives of the San Joaquin River Water Quality Management Group:

Recognizing the interconnected nature of water quality, water supply, fish and wildlife and wildlife habitat protection issues, members of the Group also want to see the primary objective accomplished in ways compatible with the following secondary objectives. Each member of the Group does not necessarily share these secondary objectives, nor do they accept responsibility for their respective implementation. They are listed here to inform policy makers of the context of the proposed recommendations and the potential impacts these recommendations could have on other programs, projects and flow or quality in the SJR basin and southern Delta
The following list of secondary objectives is not in any priority nor is it necessarily all-inclusive.

a. Implement the Delta Improvements Package (DIP).
b. Minimize Delta water losses that impact CVP-SWP exports.
c. Maintain adequate flows and water levels in the San Joaquin River between Vernalis and the head of Old River to support diverters.
d. Maintain adequate water levels in the south Delta.
e. Improve Delta water quality for ecosystem and drinking water uses through DIP actions such as Franks Tract levee restoration .
f. Maintain viability of wildlife managed wetlands and irrigated agriculture.
g. Reduce demands on New Melones Reservoir to achieve water quality and flow objectives, including but not limited to Vernalis salinity and flow, and DO on the Stanislaus River.
h. Minimize re-directed impacts
i. Meet interior Delta salinity objectives.

Figure 1 Lower San Joaquin River



4. Summary Nature of the Salinity Problem

The spatial and temporal nature of the salinity problems in the LSJR at Vernalis and downstream are described in the CVRWQCB's TMDL reports. However, this description is out of date. It did not include recent flow information incorporating a reduction in agricultural drainage as a result of implementation of the Grasslands Bypass Project. It also did not incorporate increases in drainage flows from managed wetlands, brought about through implementation of the Central Valley Project Improvement Act and the newly available managed wetland water supplies. These changes are discussed further below in section 6.a. In brief, the salinity problem for the LSJR is relatively high loadings of agricultural and urban sources of dissolved solids during periods of low river flows. High salinity levels are believed to threaten beneficial use of water in the LSJR for agricultural uses during the growing season. Additionally, the secondary maximum contaminant level for drinking water beneficial uses is 900µS/cm EC. Achieving the agriculturally- based standards will also protect drinking water beneficial uses.

5. Summary Nature of the Dissolved Oxygen Problem

The DO problem in the Deep Water Ship channel is not well understood and its causes are a matter of ongoing controversy. The CVRWQCB's report on DO describes the problem as a three-way interaction of low river flows[5], the presence of an unnaturally deep channel structure (Stockton Deep Water Ship Channel) and loadings of oxygen demand substances from upstream urban and agricultural sources. These factors together create a slack-water zone with low light penetration and resulting anoxic conditions. Low DO is thought to be a problem for resident and anadromous fish migration.

6. Baseline Conditions

a. Salinity

San Joaquin River watershed hydrology and operations are derived from a preliminary baseline study that was developed as part of Reclamation's on-going CALSIM refinement effort. This on-going effort is updating a 1980s-vintage depiction of numerous San Joaquin watershed attributes, including:

- Land-use based diversion requirements for East-side tributary systems
- East-side tributary system and Friant Division operations

[5] Data developed in the process of this report show that more water currently passes Vernalis and the Head of Old River in dry and critically dry years in July-October, when the DO problem is predominant, than would have occurred under unimpaired flow conditions.

- West-side return flows, inclusive of current wildlife area water supplies and operations
- Current regulatory and institutional operational objectives
- Linked Node approach to water quality modeling (disaggregation of water quality elements)

The refined baseline is substantially different from the earlier baseline. In particular, the refined baseline shows a dramatic change in San Joaquin River water quality related to the new baseline of flows. The CALSIM model reflects flows that would occur under current hydrologic and water management conditions. The findings herein assume that the baseline is static moving out in time and the reader should recognize that changes in the baseline due to independent actions may occur. New Melones dilution requirements now occur during winter, spring and summer months, in contrast to the earlier baseline depiction that suggested that dilution requirements were generally limited to summer months. This paradigm shift results from tracking known flow sources and their associated water quality (based on recent records) as opposed to using flow-salinity relationships (based on older records). The summer dilution requirement is much lower in the refined baseline, apparently a reflection of changed conditions within the watershed.

The earlier baseline depicted a Vernalis salinity objective with a period of exceedences in approximately one-third of all years. The refined baseline characterizes Vernalis salinity exceedences as follows:

- 13 monthly exceedences occur over the 73-year period of analysis. These exceedences occur during 8 different water years. 8 of these monthly exceedences occur during 5 years of the 1987-92 drought. 6 of these monthly exceedences occur during summer months (July-September). Baseline Vernalis salinity exceedences were most severe in 1992, the final year of an extended 6-year drought. In 1992, the Vernalis salinity objective called for 58,000 acre-ft of dilution flow above the limit established by the New Melones Interim Operations Plan (IOP). The baseline study showed a deviation of 310 uS/cm (44%) above the salinity objective during the latter half of May 1992. In 1992 and other years, baseline June through August Vernalis salinity exceedences resulting from IOP limits were significantly dampened by New Melones releases for Stanislaus River DO. During the months of June through August, the maximum deviation above the salinity objective was 37 uS/cm (5%).

- While 1992 showed the most severe baseline conditions on an annual basis, February salinity exceedences tended to be the most severe on a monthly basis. Four of the 13 monthly exceedences over the 73-year simulation period occurred in February; these exceedences required an additional 10,000 to 22,000 acre-ft of dilution flow above the limit established by the

New Melones IOP. In the baseline study, the maximum deviation above the February salinity objective was 250 uS/cm (25%).

b. Dissolved Oxygen

Low DO generally occurs in the Stockton Deep Water Ship Channel downstream to about Turner Cut. The point of greatest DO depletion tends to shift downstream with increased flow rates. Low DO is rarely a problem when flows through the Deep Water Ship Channel exceed about 1,500 cfs. Worst months for DO tend to be June through October of dryer years with excursions about a third of the time during this period. Exceedences can also occur, however, in winter months of dryer years when flow is low.

Average DO concentrations have been compiled by the California Department of Water Resources since 1983 from a DO meter installed at the northern end of Rough & Ready Island. Table 4-1 from the CVRWQCB's DO-TMDL report illustrate the temporal distribution of the low DO impairment. Oxygen concentrations less than 5.0 mg/L have occurred during all months of the year. The frequency of exceedences are worse in dry years, like 1991 and 1992 and less frequent during wet years like 1998.

In preparing the DO TMDL report the CVRWQCB also correlated the daily minimum DO concentrations with the net daily flow rate taken on the same day. This information is presented in graphical form on Figure 4-3 of the report.

7. Solution Tools Evaluated

A variety of flow augmentation and pollution reduction tactics or tools were evaluated in the development of the San Joaquin River Water Quality Management Plan. Table 4 describes the results of individual analysis of each tool. Promising tools were combined and their effects modeled as described in the following sections.

8. SANMAN Model and Modeling

The SANMAN Model Detailed Assumptions Paper, May 24, 2005 summarizes the logic used in SANMAN to estimate water quality effects of the various San Joaquin River Salinity Management actions measured at Vernalis. While the main focus of SANMAN is flow and salinity at and above Vernalis, the model also estimates net flow at Stockton, which can be useful in addressing flow-related aspects of DO impairment.

a. Baseline CALSIM Studies

Because a CALSIM study with an updated San Joaquin River basin hydrology and operations fully integrated into a system-wide hydrology and operations is not currently available, two CALSIM studies were employed to characterize Delta and San Joaquin River baselines in SANMAN.

Hydrology and operations for the Delta and Sacramento River watershed are based on the final (Environmental Water Account) step of Reclamation's OCAP CALSIM Study #5 dated January 21, 2004. Assumptions include, among other things, a 2020 level of development, Banks Pumping Plant at a permitted capacity of 8500 cfs, Tracy Pumping Plant at a full permitted 4,600 cfs, a 400 cfs DMC-California Aqueduct intertie, SWP and CVP water transfers, EWA and JPOD actions, and Cross Valley Canal wheeling. The SANMAN period of analysis approximates the CALSIM 73-year hydrologic sequence, including the period March 1922 thru September 1994. The analysis uses a monthly time step except during the April-May period, when a split-month time step is used.

Integrated operations are included in the CALSIM modeling assumptions that includes the SWP conveying 100 TAF of Level 2 refuge water at the Banks Pumping Plant prior to September 1 of each year. In exchange, the CVP provides up to 75 TAF of its supplies to reduce the SWP's obligation to comply with Bay-Delta water quality flow requirements.

Hydrology and operations for the San Joaquin River watershed are derived from a preliminary baseline study developed as part of Reclamation's on-going CALSIM refinement effort. As noted above, the modeling assumes a static baseline moving forward in time. Other changes not modeled could affect the modeled outcomes. Refinement or revision of watershed attributes include East-side land-use and tributary operations, Friant Division operations, West-side return flows, current wildlife area supplies and operations, disaggregation of various water quality elements and current regulatory and institutional objectives.

b. Vernalis Salinity Objective

The baseline Vernalis salinity objective is in accordance with D-1641: 0.7 mS/cm during April thru August and 1.0 mS/cm during September thru March. To allow post-analysis of changing San Joaquin River conditions, SANMAN removes the baseline New Melones operation provided by CALSIM to determine the New Melones baseline releases that could be modified and re-operated in reaction to changed water quality conditions in the San Joaquin River, and to provide a "without New Melones water quality release" depiction of flow and quality at Vernalis. SANMAN then re-operates New Melones in accordance with the IOP to meet Vernalis water quality objectives with SANMAN computations of water quality mass balance.

Table 4. Solution Tools Evaluated

Tools	Evaluation Findings
Flow Tools	
Recirculation	Effective when capacity is available and Delta water quality is good to provide salinity reduction and improve river flows. Analyzed July- September.
Transfers	Up to 12,000AF of water upstream in San Joaquin River watershed may be available on an interim basis for strategic transfer and targeted salinity improvements needs.
HORB Operations	Planned HORB operations in conjunction with an SDIP will improve LSJR flows downstream of Old River. Expanded operation ability for the barrier should be sought to expand benefits during critical periods (e.g. July-Sept).
Tributary Reoperation	Real-time management opportunities exist in many years to coordinate planned releases for other purposes which can result in water quality improvement.
Load Reduction/Management	
West Side Regional Drainage Plan Actions	Execution alone against baseline will remove enough salts to assure salinity compliance at Vernalis and save water in New Melones; associated DO load reductions.
Interception of Saline Groundwater at River	Expensive relative to other load reduction techniques available.
Storage for Agricultural Discharges	Impractical relative to other load reduction techniques available. Attractive nuisance issues for waterfowl. Potential strategic application.
Re-management of Managed Wetland Discharges	Necessary to address critical spring periods in conjunction with upstream releases; more study needed.
Franks Tract Reconstruction	Promising long-term action to reduce load generation.
Urban recycling/exchanges for High quality river flows	Minimal potential.
Increased wastewater treatment	Adopted ammonia load reductions for Stockton WWTP will lower DO loading.
Other: DO Aerator	Demonstration Project Aerator should proceed and be studied in conjunction with other tools implemented.

c. Delta Conditions

Delta export water quality at Banks and Tracy is assumed to correlate with CALSIM-derived water quality at Rock Slough. Stockton flow, a surrogate measure of DO conditions, is estimated as a function of Vernalis flow, barrier operations at the Head of Old River, and San Joaquin River consumptive use between Vernalis and Stockton.

d. New Melones Interim Operations Plan

New Melones baseline water quality and DO releases[6] were removed and re-introduced in accordance with the IOP. Annual accounting of New Melones water quality releases follows a March through February water year and is linked to five water supply classifications.

e. Delta Pumping Capacity Availability for Recirculation

The following pumping capacity priorities were established for modeling purposes to arrive at the net capacity available for recirculation operations, based on a physical capacity at Banks of 8,500 cfs:

- The priority for Tracy pumping capacity is as follows: (1) CVP contract deliveries, (2) export of additional CVP stored water, (3) CVP water transfers, (4) SWP exports through JPOD, and (5) DMC re-circulation.
- The priority for Banks capacity is as follows: (1) SWP contract deliveries, including a July through September EWA reservation up to 500 cfs, (2) SWP water transfers, (3) additional EWA reservation and CVP export/refuge supplies through JPOD, and (4) recirculation.
- Availability of Delta pumping capacity at Banks and Tracy is constrained by the maximum export-to-inflow (E/I) ratio as specified in D-1641. SANMAN allows the user to define recirculation alternatives that "purchase" additional pumping capacity by releasing additional Delta inflow, thereby "paying" the E/I cost.

Other assumptions related to exports for contract deliveries, additional export of CVP stored water, water transfers, the Environmental Water Account, JPOD and "lumped" summer capacity are contained in the SANMAN Model Detailed Assumptions Paper, May 24, 2005.

9. Modeling Results and Preferred Alternative Recommendation

a. Modeling Results

Over forty modeling runs were made analyzing Group defined actions for evaluation, used alone and in conjunction with each other. Early on, the effects of the West Side Regional Drainage Plan (including the San Joaquin River Improvements Project – SJRIP) were shown to be the most powerful action among the alternatives in reducing salinity levels in the LSJR (See Appendix A for a summary description of the West Side Regional Drainage Plan). Summary

[6] DO objective on the Stanislaus River near Ripon

modeling results with 100% of the West Side Regional Drainage Plan implemented with varying levels of Managed Wetland management actions and upstream transfers are summarized in Appendix B

Full implementation of the West Side Regional Drainage Plan will take up to five years for all of the remaining agricultural irrigation subsurface drainage water from about 100,000 acres within the Grasslands Drainage Area, where the Plan is focused, to be permanently removed. With funding for additional land purchases of about 2,000 acres and improvements of lands to allow reuse of drain water, but prior to development of full treatment of residual drainage flow, discharge of salts will continue to trend downward as salts are temporarily stored in reuse lands until treatment is available near the end of the five year period.

The Group's recommendations to meet its primary objectives of achieving salinity objectives at Vernalis and to improve the ability to meet DO levels in the Stockton DWSC are as follows:

b. Preferred Alternative Recommendation

<u>Salinity</u>

1. Fully implement the West Side Regional Drainage Plan.

2. Further evaluate and pursue managed wetland drainage management actions to mitigate impacts of February through April drainage releases.

3. Develop a real-time water quality management coordination group involving LSJR tributaries, LSJR drainers and the DWR to coordinate reservoir release and SWP/CVP Project operations (head of Old River barrier and New Melones operations) to realize opportunities to improve water quality and increase the utility of stored water releases.

<u>Dissolved Oxygen</u>

4. Pursue additional use of the Head of Old River Barrier to augment flows in the LSJR and the Deep Water Ship Channel, consistent with the need to maintain adequate in-Delta water quality, water level and fishery protection.

5. Support for continued implementation of the City of Stockton's ammonia removal project at the Stockton WWTP.

6. Install the demonstration aeration project in the DWSC and continue the newly implemented upstream monitoring efforts to understand DO load producing discharges.

7. Evaluation of additional actions necessary for DO compliance at the DWSC following implementation and analysis of actions 1-5.

8. Establish a forum to evaluate ongoing changes in the water quality baseline and suggest further management actions to continue progress on water quality improvement.

The following summarizes the effects of the Preferred Alternative on Vernalis salinity and flow, effects on storage at New Melones Reservoir, and effects on the level of DO at the DWSC.

c. Vernalis Salinity

The Preferred Alternative meets the Vernalis salinity objective over the entire 73-year period of analysis without the need for upstream water transfers. Recall that the baseline shows exceedences in 13 months over the 73-year period of analysis.

Figure 2 compares critical year monthly average Vernalis salinity under the baseline and Preferred Alternative, both in absolute terms and in terms of percent reduction. Salinity reduction is most impressive in summer months, when the average reduction ranges between 25 and 35%. The figure shows that the Vernalis objective is met with a large factor of safety in most months of critical years. Critical year average salinity most closely approaches the Vernalis objective during February, March and the latter half of May.

d. Vernalis Flow

A consequence of the Preferred Alternative’s drainage reduction action and (and associated smaller demand for New Melones dilution flow) is reduced flow at Vernalis. Figure 3 compares critical year monthly average Vernalis flow under the baseline and Preferred Alternative, both in absolute terms and in terms of reduction.

Flow reduction is greatest in the month of March. The average critical year March flow reduction of 270 cfs is due mainly to lower New Melones releases (220 cfs). Although of much smaller magnitude, the critical year flow reductions during summer months is of greater concern to downstream agricultural water users, as baseline flows of approximately 1000 cfs are considered by these users to be marginal. Critical year average flows in July are reduced from 920 cfs to 860 cfs. Most of the 60 cfs flow reduction (50 cfs) is a direct result of drainage reduction.

e. New Melones Storage

Due to the lower need for Vernalis dilution flow, additional water storage would remain available in New Melones Reservoir for other purposes in the amount of 23 TAF in a critical year and 8 TAF per year over the 73-year period of analysis. The additional water storage that results from lower dilution flow is offset somewhat by higher needs for Stanislaus River DO flow, otherwise now provided incidentally from the salinity flow. Additional water storage is greatest in dry and critical years, as dilution requirements are small in wetter years under baseline conditions.

Figure 4 compares annual dilution volumes from New Melones under the baseline and Preferred Alternative over the 73-year period of analysis. Under the baseline, New Melones releases are required in 34 of the 73 years, or just under half the time. The maximum dilution requirement under the baseline is 78 TAF. Under the Preferred Alternative, New Melones dilution flows are required in only 17 of the 73 years, with a maximum annual requirement of 25 TAF. The Preferred Alternative eliminates dilution needs in summer months. Nearly all the Preferred Alternative dilution requirement occurs in February and March. This results highlights the value of evaluating and pursuing actions to mitigate impacts of drainage releases from managed wetlands and other sources to the San Joaquin River during February and March.

Figure 5 compares annual dilution volumes by water year type. Average dilution requirements are reduced from 60 to 8 TAF in critical years and from 19 to 2 TAF over the 73-year period of analysis; the Preferred Alternative effectively eliminates dilution requirements in all but dry and critical water years.

Figure 6 illustrates how additional New Melones water storage that results from lower dilution flow is offset somewhat by higher needs for Stanislaus River DO flow. Adopting modeling assumptions from CALSIM, the SANMAN analysis assumes that a minimum annual flow volume of 60 TAF, distributed over the months of June through September, is required to meet DO requirements on the Stanislaus River. Average DO requirements are increased from 25 to 54 TAF in critical years and from 13 to 22 TAF over the 73-year period of analysis.

Figure 7 sums New Melones dilution and DO requirements and shows comparisons by water year type. As reported in a previous paragraph, the Preferred Alternative reduces New Melones demands by 23 TAF in critical years (from 85 to 62 TAF) and by 8 TAF per year (from 32 to 24 TAF) over the 73-year period of analysis.

Figure 2
Vernalis Salinity by Month: Critical Year Average

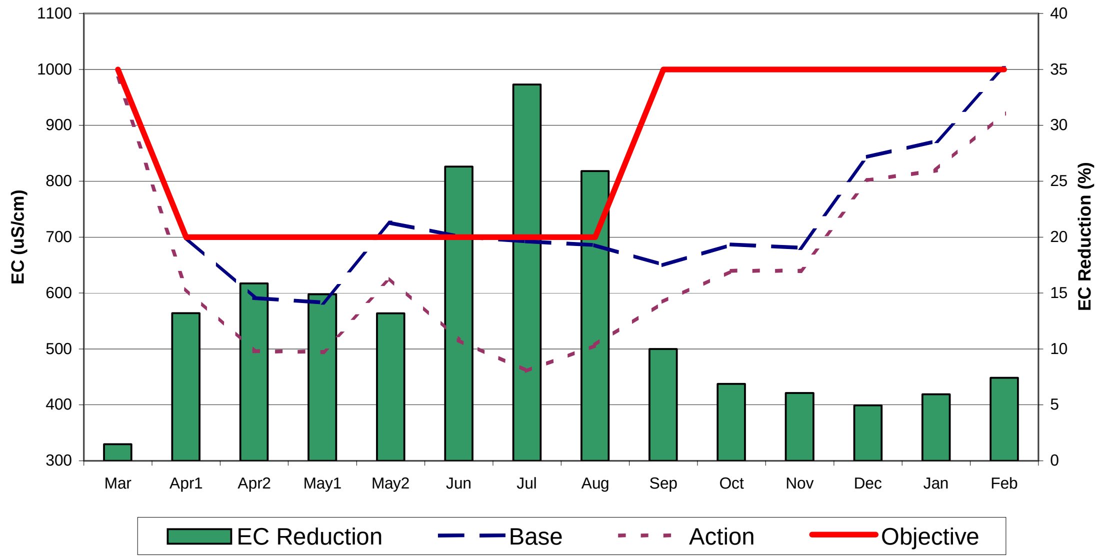


Figure 3
Vernalis Flow by Month: Critical Year Average

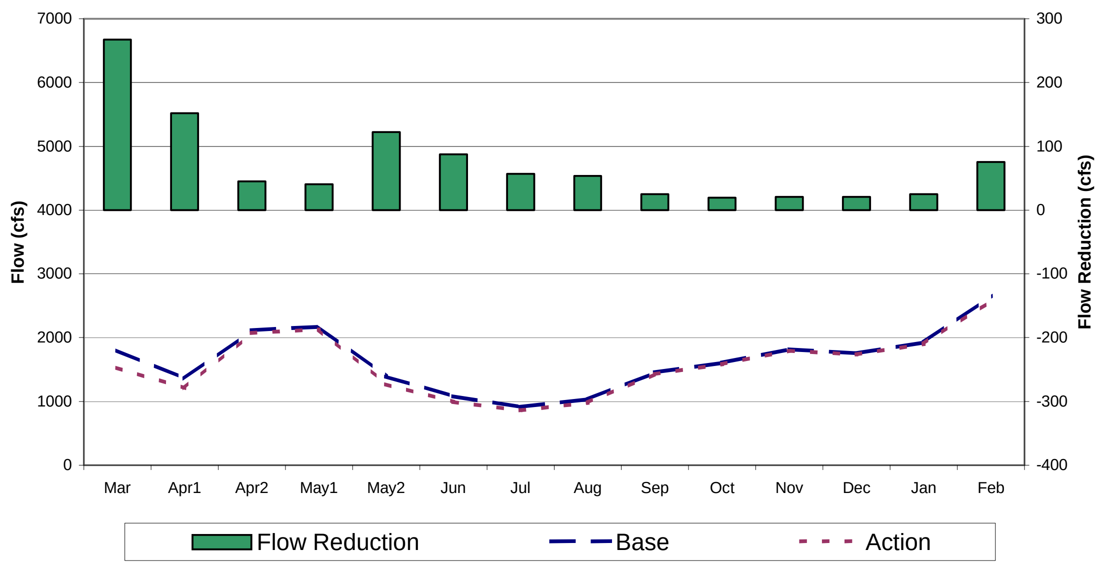


Figure 4
New Melones Water Quality Releases: 1922-94

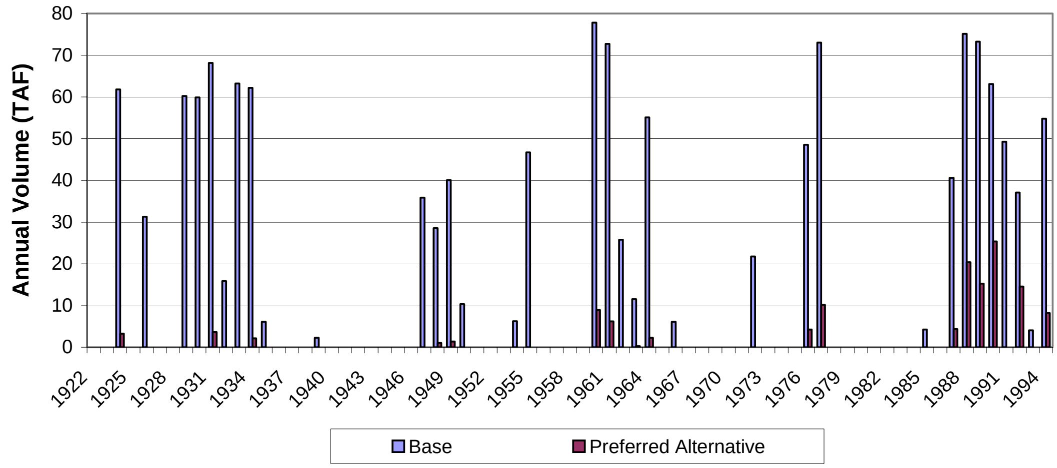


Figure 5
New Melones Water Quality Releases by SVI Water Year Type

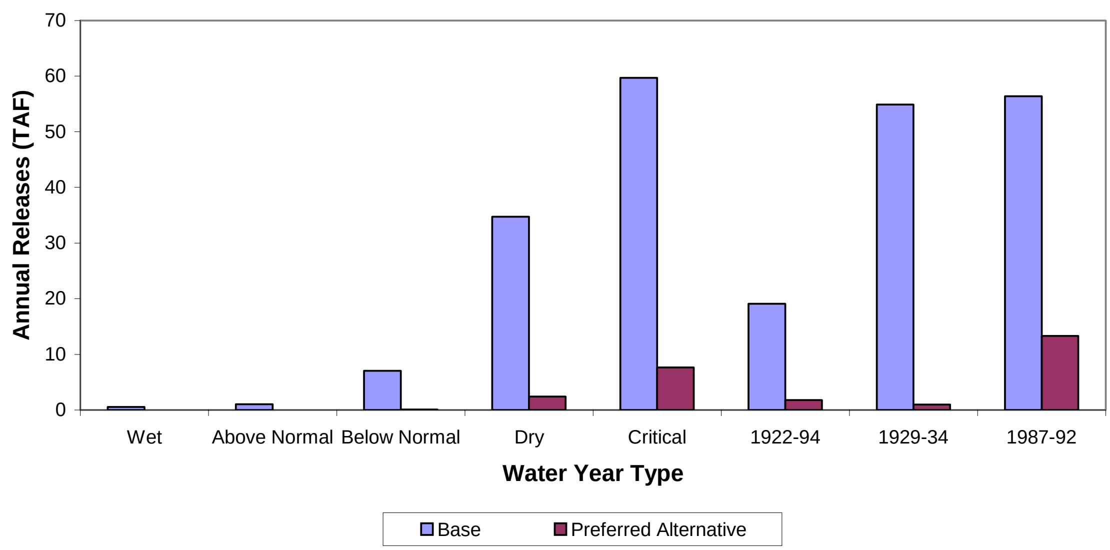


Figure 6
New Melones Stanislaus River Dissolved Oxygen Releases by SVI Water Year Type

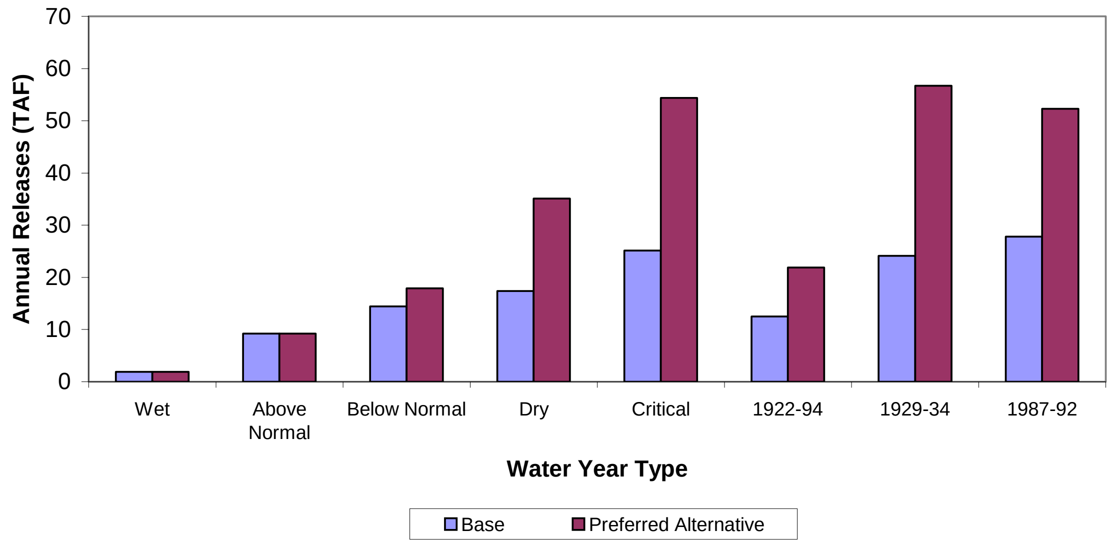
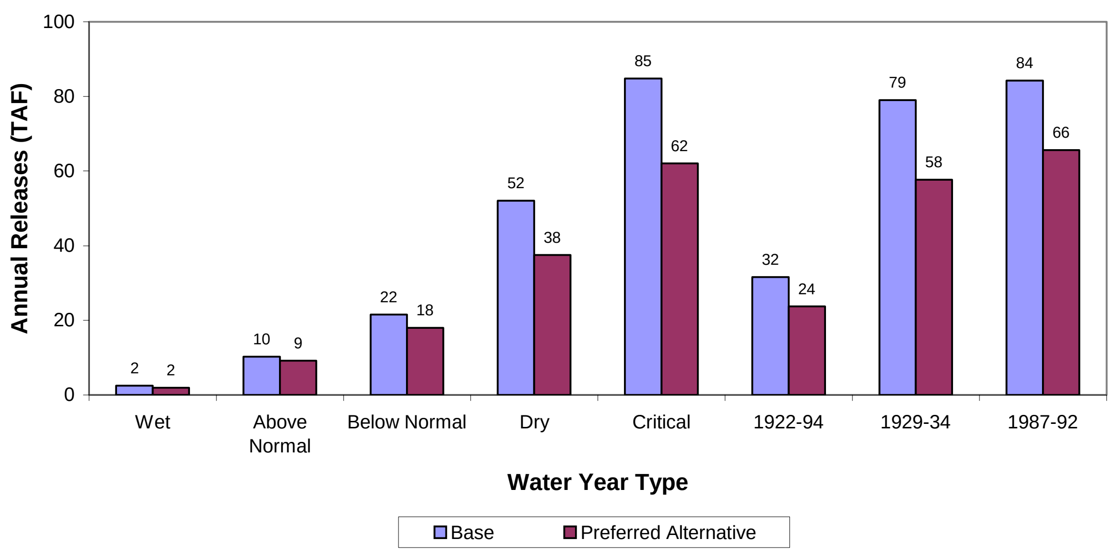


Figure 7
New Melones Salinity & Dissolved Oxygen Releases by SVI Water Year Type



f. Dissolved Oxygen

While elimination of episodes of low DO remains a primary objective of the plan, the need for and efficacy of the tools to address this problem can not be accurately predicted at this time due to the more dynamic nature of that problem and lack of reliable models which account for all the variables in play. However, an operable Head of Old River barrier will increase flows in the LSJR, as shown in Figures 8 and 9, cutting the frequency of flows below 500cfs in half as compared to the baseline in July and August. In September the efficacy of HORB operations is even greater, as shown in Figure 10. Coupled with the City of Stockton's ammonia removal project and provided the demonstration project aerator, which can artificially supplement channel oxygen levels, proves effective, it is believe that DO excursions can be significantly reduced. Operation of these tools on a real time basis will allow experience to be developed in refining how the tools can be applied over time given various circumstances in order to find the precise combination of actions that can achieve the objective. Further, as additional studies progress on upstream loads and flows, the collective understanding of this problem and the ability to solve it should improve with time.

As operational experience is gained combining HORB operations, reductions of salt and DO load and operation of a demonstration aerator occur, further analysis should be done to investigate any additional needed actions to fully resolve remaining DO issues at the Deep Water Ship Channel.

Figure 8 July Stockton Net Flow: Cumulative Frequency Distribution

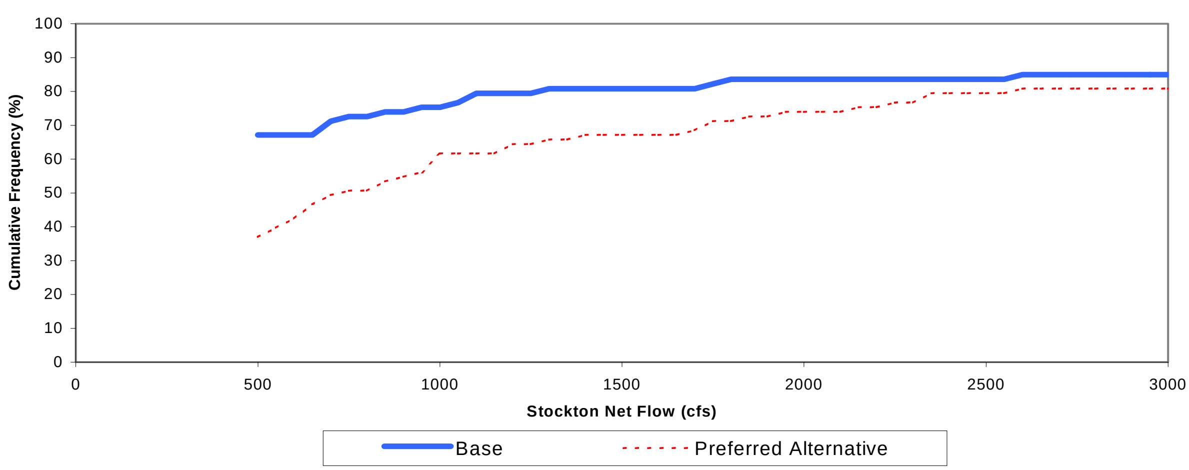


Figure 9
August Stockton Net Flow: Cumulative Frequency Distribution

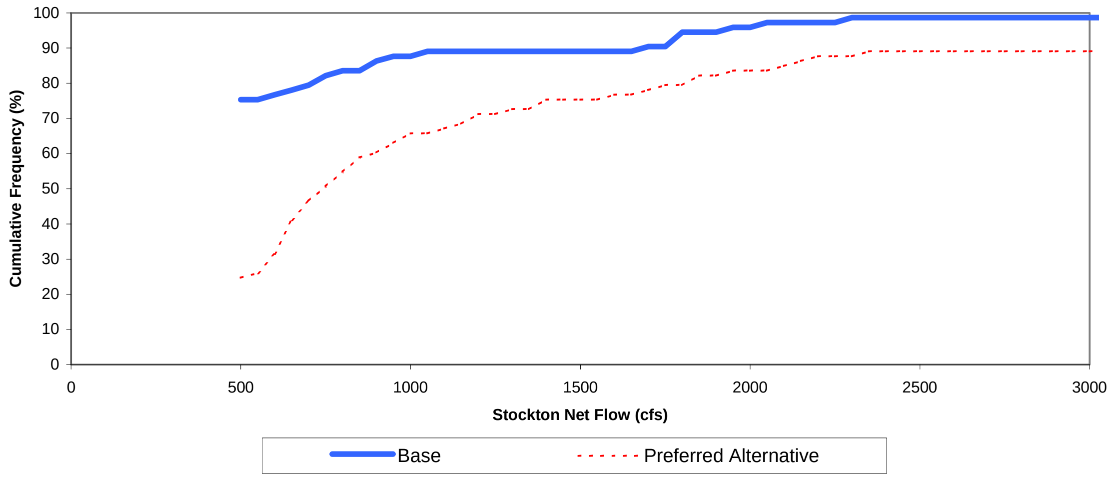
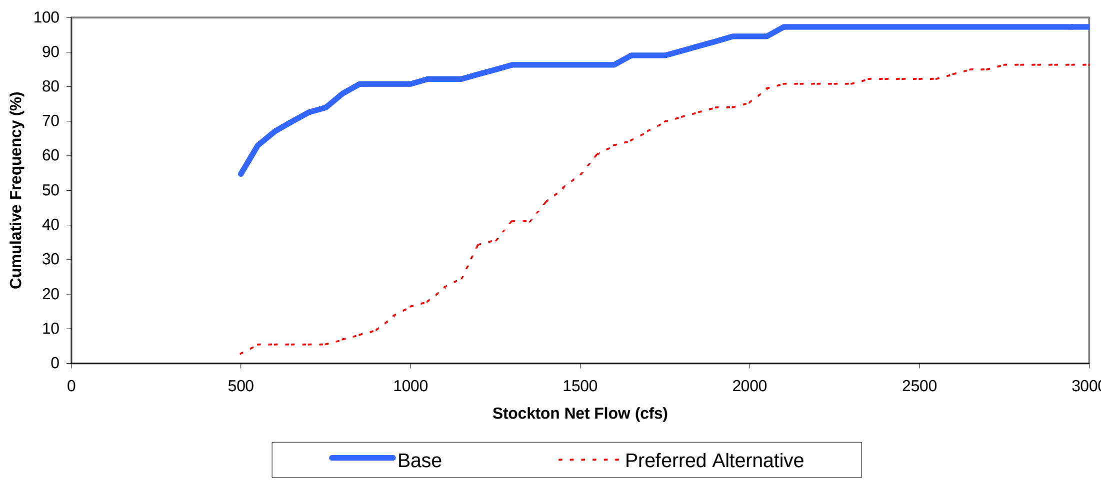


Figure 10
September Stockton Net Flow: Cumulative Frequency Distribution



10. The Evolving Baseline and Other River Changes

Due to this Group's efforts and the efforts of many others involved in addressing LSJR issues, it is widely recognized that factors affecting water quality on the San Joaquin River are dynamic and subject to change, often outside the reach of regulatory authority or control. Land uses in the watershed will convert from agricultural and other uses to urban uses. Cropping types and practices will evolve to meet market demands. Water conservation efforts will likely result in diminished return flows to the river and growing urban areas will return additional sewage treatment plant effluent. Additionally, potential regulatory changes on rivers upstream of the LSJR, such as a decision to move a compliance point for DO on the Stanislaus river from Ripon to Orange Blossom Bridge, will have secondary effects on flow on the LSJR. Both inevitable and discretionary changes should be evaluated for ultimate effects on continuing to achieve water quality improvement. Tools evaluated here such as recirculation, could be employed to offset some effects of these decisions or changes that otherwise cause lower river flows. For these reasons the Group recommends a forum be established to track these changes and evaluate and recommend necessary actions to continue water quality improvement.

11. Effects of Recommended Actions on Secondary Objectives

Appendix B details results of studies done utilizing the tools analyzed herein to meet primary and secondary objectives.

Lowered flows/flow maintenance on LSJR. Implementation of the West Side Drainage Plan and resulting lower reliance on New Melones releases for achievement of salinity objectives lowers flows on the LSJR during critical months as much as from 920 to 860cfs on average in July of critical water years, or just under a 7% flow reduction. Flows below 1,000 cfs are a potential problem for diverters on the LSJR, where the water level drops below pump intakes. Where lowering occurs in summer months of these year types, recirculation could be utilized to provide for additional flow to allow water surface levels to rise to meet pump intake levels.

(In-Delta) Brandt Bridge salinity objective. The recommended actions would improve salinity conditions at Brandt Bridge but water quality degradation below Vernalis causes salinity levels to rise in that stretch of the river between Vernalis and Brandt Bridge. Additional flow or load reduction would be needed to fully meet this objective.

Water Costs. The SANMAN model computes two water cost values: (1) "net" water cost that includes all Delta components and (2) "re-circulation" water cost, a subset of "net" water cost that is limited to re-circulation components (as shown in Appendix B). The reason for this distinction is that water costs other than those associated with "re-circulation" are operational actions of the SWP/CVP operating systems in response to the effects of implementing the San Joaquin River Salinity Management actions.

12. Next Steps

a. Funding Needed.

Table 5 indicates recommended actions, funding needed and recommended funding sources to implement the recommendations herein.

Table 5.
Funding Needs and Sources to Implement the Preferred Alternative

Recommendation	Funding Needed	Recommended Source
1. Implement Drainage Plan	$86 million, capital $3-5m annual operations	Federal/State bond/local Federal
2. Managed Wetlands Actions	$250,000 initial studies	All participants
3. Real Time Operations	Existing staff/stakeholders	Local
4. HORB operations	Existing funding/staff	State
5. Stockton WWTP	Funded	CALFED – capital; stakeholders agreement for operations
6. DO Aereator	Funded capital, $200,000 operations	
7. Continued DO evaluation	Unknown/nominal	CVRWQCB/stakeholders
8. Lower River Forum	Nominal	Agencies/stakeholders

b. CEQA/NEPA needs analysis.

Key aspects of the proposed recommendations are proceeding under separate planning functions, with appropriate environmental review, including the South Delta Improvements Project and the West Side Regional Drainage Plan and are expected to be complete by summer of 2006. An analysis any additional CEQA and NEPA documentation that would be necessary for the recommendations overall needs to be undertaken.

c. Agreement.

Some of the parties participating in this Group will need to enter into an MOU on implementation of the recommended actions.

Apendix A

Summary Description of the West Side Regional Drainage Plan

The West Side Regional Drainage Plan is an integrated plan to eliminate irrigated agricultural drainage water from and enhance water supply reliability for, about 100,000 acres in the Grasslands Drainage area as shown in Figure A-1. The Program began as a successful effort to reduce selenium discharges to the San Joaquin River. It is now been proposed for expansion to go beyond regulatory requirements and eliminate selenium and salt discharges to the River, while maintaining productivity of production agriculture in the region and enhancing water supplies to lands remaining in production. It also is key to solving disputes among neighboring water and drainage districts regarding localized impacts of agricultural drainage.

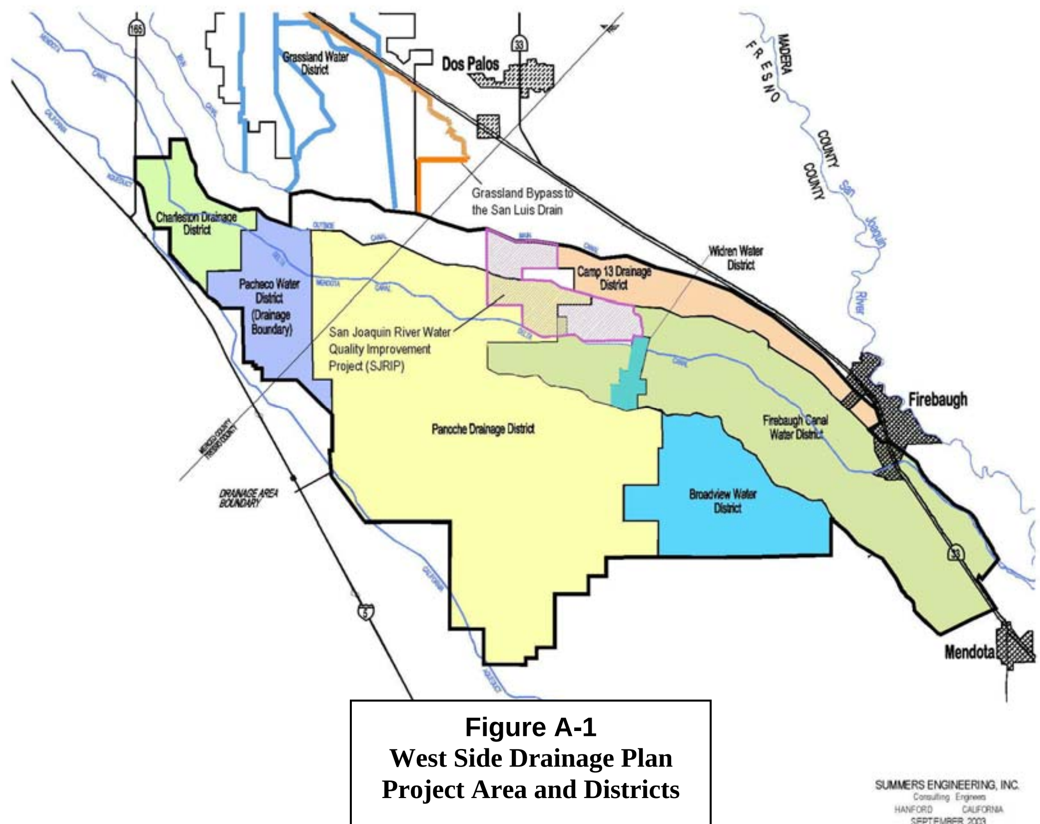
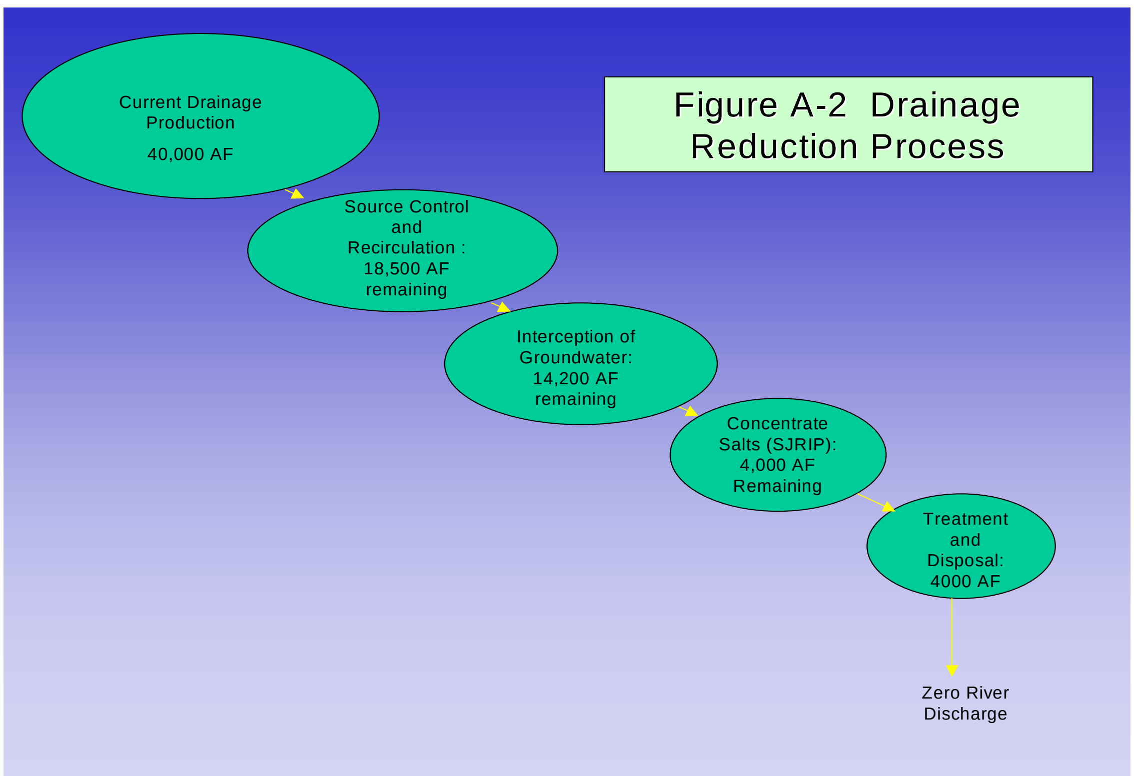


Figure A-1
West Side Drainage Plan
Project Area and Districts

The Plan relies on four general tactics to reduce and then eliminate high salinity irrigation drainage from these lands:

1) Reduction of drainage volumes to be managed through source control/efficient water management techniques such as replacement of furrow irrigation with micro-irrigation technology, and lining of unlined delivery canals;
2) Recirculation of tailwater on primary irrigation lands;
3) Collection and reuse of tile drainage water on halophytic croplands in order to concentrate drainage'
4) Installation of groundwater wells to lower groundwater in strategic locations to eliminate groundwater infiltration into tile drains.
5) Treatment and disposal of remaining drainage water through reverse osmosis, evaporation and disposal or reuse of salts.

The use of these techniques and the consequent reduction in drain water is graphically displayed in Figure A-2



With about 4,000 acres of land currently being used as drainage water re-use area, reductions of salt discharges through the San Luis Drain and into Mud Slough then to the San Joaquin River have decreased. Further action on the Plan will eliminate the remaining discharge. An incidental benefit of this Plan that has been found through analysis by the San Joaquin River Water Quality Management Group is that it assures compliance with salinity objectives at

Vernalis and reduces the frequency in violations of objectives at Brandt Bridge by 71% over a 73-year hydrology.

About $66 million has been spent on the Plan thus far and another $86.5 million is necessary to complete the Plan's implementation over the next four years as shown in Table A-1.

Table A-1
West Side Regional Drainage Plan Cost Summary

Solution Component	2005	2006	2007	2008	2009	2010	Total
Irrigation Improvements	**$4,720,000**	**$4,540,000**	**$4,540,000**	**$4,540,000**	**$2,300,000**		**$20,640,000**
-Panoche DD/Pacheco WD/Charleston DD	$3,714,000	$3,572,000	$3,572,000	$3,572,000	$1,810,000		$16,240,000
-Exchange Area	$526,000	$506,000	$506,000	$506,000	$256,000		$2,300,000
-Westlands WD	$480,000	$462,000	$462,000	$462,000	$234,000		$2,100,000
Distribution Facility Improvements	**$2,700,000**	**$5,400,000**	**$2,690,000**				**$10,790,000**
-Panoche DD	$956,000	$1,912,000	$952,000				$3,820,000
-Exchange Area	$1,744,000	$3,488,000	$1,738,000				$6,970,000
-Westlands WD	$0	$0	$0				
BVWD Reuse Project (Westlands WD)			$440,000	$880,000			**$1,320,000**
Westland W.D. Shallow Groundwater Pumping			$1,000,000	$1,000,000	$1,000,000		**$3,000,000**
Groundwater Management (Exchange Contractors)				$6,000,000	$6,000,000		**$12,000,000**
SJRIP Expansion and Development	$4,170,000	$4,170,000	$4,160,000	$4,160,000	$4,160,000		**$20,820,000**
Treatment Plant Development	$1,600,000	$3,280,000	$3,270,000	$3,200,000	$3,200,000	$3,200,000	**$17,750,000**
Total	**$20,610,000**	**$27,330,000**	**$23,330,000**	**$24,320,000**	**$18,960,000**	**$3,200,000**	**$86,320,000**

Appendix B
SANMAN Modeling Results

Summary San Joaquin River Water Quality Action Alternatives:
Critical Year Averages

	Number of Exceedences			Delta	DMC Recirculation			New	Transfers	
	Vernalis Salinity	Vernalis Flow	Brandt Bridge Salinity	Water Cost (taf/yr)	Volume (taf/yr)	Energy Cost ($1000/yr)	Water Cost (taf/yr)	Melones Savings (taf/yr)	Max (taf)	Ave (taf/yr)
Interim Period (100% West Side Drainage Implementation & No Wetlands Mgt): Without Transfers										
1) Meet Vernalis Salinity	0	---	---	53	0	0	0	23	0	0
2) Study 1 + 1000 cfs @ Vernalis	0	11	---	56	19	230	3	23	0	0
3) Meet Brandt Bridge Salinity (0.7/1.0)	0	---	84	53	0	0	0	23	0	0
4) Study 3 + 1000 cfs @ Vernalis	0	11	84	56	19	230	3	23	0	0
5) Study 4 + 750 cfs @ Stockton July-Sept	0	11	84	67	85	1020	15	23	0	0
6) Meet Brandt Bridge Salinity (1.0)	0	---	43	53	0	0	0	23	0	0
7) Study 6 + 1000 cfs @ Vernalis	0	11	43	56	19	230	3	23	0	0
8) Study 7 + 750 cfs @ Stockton July-Sept	0	11	43	67	86	1030	15	23	0	0
Interim Period (100% West Side Drainage Implementation & No Wetlands Mgt): With Transfers										
9) Meet Vernalis Salinity	0	---	---	53	0	0	0	23	0	0
10) Study 9 + 1000 cfs @ Vernalis	0	0	---	47	19	230	3	23	34	9
11) Meet Brandt Bridge Salinity (0.7/1.0)	0	---	0	34	0	0	0	23	27	19
12) Study 11 + 1000 cfs @ Vernalis	0	0	0	29	19	230	3	23	54	27
13) Study 12 + 750 cfs @ Stockton July-Sept	0	0	0	40	85	1020	15	23	54	27
14) Meet Brandt Bridge Salinity (1.0)	0	---	0	37	0	0	0	23	23	16
15) Study 14 + 1000 cfs @ Vernalis	0	0	0	32	19	230	3	23	46	24
16) Study 15 + 750 cfs @ Stockton July-Sept	0	0	0	43	86	1030	15	23	46	24
Long Term (100% West Side Drainage Implementation & Wetlands Mgt): Without Transfers										
17) Meet Vernalis Salinity	0	---	---	58	0	0	0	28	0	0
18) Study 17 + 1000 cfs @ Vernalis	0	12	---	61	19	230	3	28	0	0
19) Meet Brandt Bridge Salinity (0.7/1.0)	0	---	49	58	0	0	0	27	0	0
20) Study 19 + 1000 cfs @ Vernalis	0	12	49	61	19	230	3	27	0	0
21) Study 20 + 750 cfs @ Stockton July-Sept	0	12	49	72	85	1020	15	27	0	0
22) Meet Brandt Bridge Salinity (1.0)	0	---	21	58	0	0	0	28	0	0
23) Study 22 + 1000 cfs @ Vernalis	0	12	21	61	19	230	3	28	0	0
24) Study 23 + 750 cfs @ Stockton July-Sept	0	12	21	73	86	1030	15	28	0	0
Long Term (100% West Side Drainage Implementation & Wetlands Mgt): With Transfers										
25) Meet Vernalis Salinity	0	---	---	58	0	0	0	28	0	0
26) Study 25 + 1000 cfs @ Vernalis	0	0	---	51	19	230	3	28	43	10
27) Meet Brandt Bridge Salinity (0.7/1.0)	0	---	0	47	0	0	0	27	24	11
28) Study 27 + 1000 cfs @ Vernalis	0	0	0	39	19	230	3	27	49	21
29) Study 28 + 750 cfs @ Stockton July-Sept	0	0	0	51	85	1020	15	27	49	21
30) Meet Brandt Bridge Salinity (1.0)	0	---	0	51	0	0	0	28	16	7
31) Study 30 + 1000 cfs @ Vernalis	0	0	0	43	19	230	3	28	46	18
32) Study 31 + 750 cfs @ Stockton July-Sept	0	0	0	55	86	1030	15	28	46	18

Assumptions:
current baseline New Melones IOP and Stanislaus dissolved oxygen requirements
additional HORB operations
high priority recirculation
dissolved oxygen aerator and Stockton NPDES actions